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Department of Computer Engineering
Bachelor of Technology (Computer Engineering), Semester III
Subject: Quantum Computing

Assignment (CA2)

5th October 2024

1. What is a qubit in quantum computing?
   A. A classical bit used in quantum computers
   B. The quantum equivalent of a classical bit, representing 0, 1, or a superposition of both
   C. A unit of quantum energy
   D. A physical particle used to store quantum information

2. Which of the following best describes superposition in quantum computing?
   A. A state where a qubit is in either 0 or 1, but not both
   B. A qubit being in a definite state until measured
   C. A qubit being in multiple states (0 and 1) simultaneously
   D. A mechanism that resets the quantum state

3. What does the process of "quantum entanglement" allow qubits to do?
   A. Retain data over time
   B. Operate independently of each other
   C. Share a state, meaning the state of one qubit directly affects the other, no matter the distance
   D. Avoid quantum decoherence

4. Which mathematical concept is essential for understanding quantum computing?
   A. Boolean algebra
   B. Linear algebra
   C. Differential calculus
   D. Trigonometry

5. What is the main advantage of quantum computers over classical computers?
   A. They operate without power.
   B. They can solve problems like factoring large numbers exponentially faster
   C. They store more data than classical computers.
   D. They do not require any physical hardware.

6. In a quantum circuit, what is a gate?
   A. A physical barrier in a quantum chip
   B. A mathematical function applied to qubits to perform computations
   C. The measure of a qubit's fidelity

D. The output state of a quantum computer

7. What is a common physical implementation of a qubit?
   A. Electrical resistor
   B. Photons, ions, or superconducting circuits
   C. Silicon transistors
   D. Optical mirrors

8. What is a relative phase shift in the context of quantum mechanics?
   A. A shift that changes the relative amplitudes of $|0\rangle$ and $|1\rangle$ states, affecting interference patterns
   B. A uniform shift applied to all components of a quantum state
   C. A change in the absolute value of the wavefunction
   D. A process that eliminates superposition

9. What is the braket notation for a qubit in superposition with equal probability of being $|0\rangle$ or $|1\rangle$?
   A. $|\psi\rangle = |0\rangle$
   B. $\frac{1}{\sqrt{2}}(|0\rangle + |1\rangle)$
   C. $\frac{1}{2}(|0\rangle + |1\rangle)$
   D. $|0\rangle + |1\rangle$

10. What does $\langle\phi|\psi\rangle$ represent in the braket notation
    A. The probability of measuring a qubit in the $|\psi\rangle$ state
    B. The inner product of states $|\phi\rangle$ and $|\psi\rangle$
    C. The sum of states $|\phi\rangle$ and $|\psi\rangle$
    D. The difference between states $|\phi\rangle$ and $|\psi\rangle$

11. A qubit is represented as $|\psi\rangle = \frac{1}{\sqrt{2}}(|0\rangle + i\,|1\rangle)$ What is the relative phase difference between $|0\rangle$ and $|1\rangle$
    A. 0
    B. $\frac{\pi}{2}$ radians
    C. π radians
    D. 2π radians

12. In quantum mechanics, what does a phase gate (e.g., the S or T gate) do to a qubit?
    A. It measures the qubit in the computational basis.
    B. It changes the phase of one state relative to another.
    C. It swaps the $|0\rangle$ and $|1\rangle$ states.
    D. It creates entanglement between qubits

13. If a qubit is in the state $|\psi\rangle = \frac{1}{2}(|0\rangle - \sqrt{3}\,|1\rangle)$ what is the probability of measuring it in the $|1\rangle$ state
    A. $\frac{1}{4}$
    B. $\frac{3}{4}$
    C. $\frac{1}{2}$.
    D. 1

14. Which of the following states is orthogonal to $|\phi\rangle = \frac{1}{\sqrt{2}}(|0\rangle + |1\rangle)$
    A. $|\psi\rangle = \frac{1}{\sqrt{2}}(|0\rangle + |1\rangle)$
    B. $|\phi\rangle = \frac{1}{\sqrt{2}}(|0\rangle - |1\rangle)$

C. $|\phi\rangle = |0\rangle$
D. $|\phi\rangle = |1\rangle$

15. What is the global phase of the state $|\psi\rangle = e^{\pi/4}(|0\rangle + |1\rangle)$
A. 0
B. $\pi/4$
C. It can not be observed directly
D. π

16. Which of the following operations is commonly used to create a relative phase shift in quantum circuits?
A. The Hadamard gate
Pauli-X gate
B. The T gate ($\pi/8$ gate)
C. The CNOT gate